

Claims

1. A reconstituted viral membrane, the lipid bilayer of which comprises a fusion protein of a virus, an amphiphilic adjuvant and, optionally, a further antigen, whereby:
 - (a) the lipid bilayer has a lipid composition that is compatible with fusion, induced by the fusion protein, of the viral membrane with the membrane of a cell that can be fused with the virus from which the fusion protein is derived;
 - (b) the fusion protein and the amphiphilic adjuvant interact with the hydrophobic interior of the lipid bilayer; and,
 - (c) the fusion protein, the amphiphilic adjuvant and the optional further antigen are not covalently linked.
2. A reconstituted viral membrane according to claim 1, wherein the lipid bilayer comprises natural lipids of a viral membrane.
3. A reconstituted viral membrane according to claims 1 or 2, wherein the amphiphilic adjuvant is a lipopeptide, a glycolipid or a peptide.
4. A reconstituted viral membrane according to any one of claims 1 - 3, wherein the amphiphilic adjuvant is a ligand for a mammalian Toll-like receptor.
5. A reconstituted viral membrane according to claim 3, wherein the lipopeptide is selected from the group consisting of: *N*-palmitoyl-S-2,3(bispalmitoyloxy)-propyl-cysteinyl-seryl-serine, S-2,3(bispalmitoyloxy)-propyl-cysteinyl-seryl-serine, *N*-palmitoyl-S-2,3(bispalmitoyloxy)-propyl-cysteinyl-seryl-(lysyl)₃-lysine, S-2,3(bispalmitoyloxy)-propyl-cysteinyl-seryl-(lysyl)₃-lysine, *N*-palmitoyl-S-2,3(bisoleoyloxy)-propyl-cysteinyl-seryl-(lysyl)₃-lysine, S-2,3(bisoleoyloxy)-propyl-cysteinyl-seryl-serine-(lysyl)₃-lysine, *N*-palmitoyl-S-2,3(bismyristoyloxy)-propyl-cysteinyl-seryl-(lysyl)₃-lysine, S-2,3(bismyristoyloxy)-propyl-cysteinyl-seryl-(lysyl)₃-lysine, *N*-palmitoyl-S-3(palmitoyloxy)-propyl-cysteinyl-seryl-(lysyl)₃-lysine and *N*-palmitoyl-S-2,3 hydroxy-propyl-cysteinyl-seryl-(lysyl)₃-lysine, *N*-palmitoyl-S-2,3(bispalmitoyloxy)-propyl-cysteinyl-seryl-(prolyl)₃-proline, *N*-palmitoyl-S-2,3(bispalmitoyloxy)-propyl-cysteinyl-seryl-(glutaminyl)₃-glutaminic acid.

6. A reconstituted viral membrane according to claim 3, wherein the glycolipid is a phosphatidyl inositol mannoside, an alpha-galactosylceramide, or a modified lipopolysaccharide having reduced toxicity.
- 5 7. A reconstituted viral membrane according to any one of claims 1 - 6, wherein the antigen is an integral membrane protein.
8. A reconstituted viral membrane according to any one of claims 1 - 7, wherein the antigen is a viral antigen.
- 10 9. A reconstituted viral membrane according to claim 8, wherein the antigen is from an influenza virus.
- 15 10. A reconstituted viral membrane according to claim 9, wherein the antigen is a hemagglutinin (HA), a neuraminidase (NA) or an M2 protein.
- 20 11. A reconstituted viral membrane according to claim 8, wherein the antigen is derived from a virus selected from the group consisting of Retroviridae, rubellavirus, Paramyxoviridae, Flaviviridae, Herpesviridae, Bunyaviridae, Arenaviridae, Hantaviridae, Coronaviridae, Papovaviridae, Rhabdoviridae, Coronaviridae, Alphaviridae, Arteriviridae, Filoviridae, Arenaviridae, poxviridae, and African swine fever virus.
- 25 12. A reconstituted viral membrane according to any one of claims 1 - 7, wherein the antigen is derived from a parasite, a bacterium, a fungus, a yeast, or wherein the antigen is a tumor-specific antigen.
- 30 13. A method for producing a reconstituted viral membrane, wherein the method comprises the steps of:
- (a) mixing an amphiphilic adjuvant, a viral fusion protein, an optional further antigen, and lipids in a solution comprising a detergent;
- (b) decreasing the concentration of the detergent under conditions that allow reconstitution of a viral membrane comprising a lipid bilayer in which the

amphiphilic adjuvant and the viral fusion protein interact with the hydrophobic interior of the lipid bilayer, whereby the amphiphilic adjuvant and the viral fusion protein are not covalently linked, whereby the amphiphilic adjuvant and the optional further antigen are not covalently linked, and whereby the reconstituted viral membrane has membrane fusion activity;

(c) optionally, purifying the reconstituted viral membrane; and,

(d) optionally, formulating the reconstituted viral membrane into a pharmaceutical composition.

14. A pharmaceutical composition comprising a reconstituted viral membrane as defined in any one of claims 1 - 12 and a pharmaceutically acceptable carrier.

15. A pharmaceutical composition according to claim 14, whereby the composition is suitable for intranasal, oral or parenteral administration.